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Low Temperature Alpha Measurement

David J. Gallant

Boeing/ Rocketdyne Technical Services
PO Box 5670
Albuquerque, NM 87185

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Final Report

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AIR FORCE RESEARCH LABORATORY
Directed Energy Directorate
3550 Aberdeen Ave SE
AIR FORCE MATERIEL COMMAND
KIRTLAND AIR FORCE BASE, NM 87117-5776

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Richard W Berdine

Richard W. Berdine, DR-II
Project Manager

FOR THE COMMANDER

LeAnn D Brasure

LeAnn D.Brasure, Lt Col, USAF
Chief, High Power Solid-State Lasers Branch

R Earl Good

DR. EARL GOOD, SES
Director, Directed Energy

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David J. Gallant

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The Boeing Company
Rocketdyne Technical Services
PO Box 5670
Kirtland AFB, NM 87185

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13. ABSTRACT ***(Maximum 200 Words)***
The objective of this task was to provide for the setup, measurement and data analysis of an experiment to measure the alpha parameter of diode lasers. The alpha parameter characterized the degree of coupling between the diode laser carriers and the material index of refraction. This parameter has been measured extensively at room temperature and this task extended the measurement regime to low temperatures.

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Table of Contents

I. INTRODUCTION

The SLIDERS contract encompassed several research efforts within the Semiconductor Laser Branch of the Laser Division, Directed Energy Directorate of the Air Force Research Laboratory. The scope of this contract included development, design, fabrication, procurement, management, operations and maintenance of optical, electronic, and mechanical systems, subsystems, and components. Principal efforts included theory and concept development, design analysis, laboratory operations, and semiconductor laser and diode-pumped laser development, operation and maintenance. Efforts also included the development, procurement, and operation of instrumentation to evaluate and characterize laser systems.

II. LOW TEMPERATURE ALPHA MEASUREMENT

The objective of this task was to provide for the setup, measurement and data analysis of an experiment to measure the alpha parameter of diode lasers. This work was a continuation of previous work on alpha parameter measurements, and was to extend measurement capabilities to other operating temperatures. The alpha parameter is a measure of the coupling between the diode laser carriers (electron current) and the material index of refraction. A lower coupling parameter is required to reduce nonlinear effects and filamentation, leading to improved beam quality and higher facet powers.

At the initiation of the task recent efforts on this experiment were reviewed and the optical layout was examined. Some of the optics were realigned, and changes to the vacuum chamber and laser mount were incorporated to facilitate an alignment laser through the vacuum chamber. Other vacuum chambers and cryogenic systems were looked into in order to vary the operating temperature of the test samples.

Additional parts were designed and machined to allow for the alignment laser and to better support the electrical current probe used to run the diode laser. The availability of diode laser samples and material on hand was reviewed.

Discussions were held with DOF personnel concerning anti-reflective optical coatings on the laser diodes. DOF typically builds a two layer AR coating so our coating model will have to be modified to account for the two layers and fixed material indices. Getting good quality optical coatings is critical. The coatings must withstand cryogenic temperatures and provide sufficient suppression of lasing for high carrier density alpha measurements.

We continued to pursue obtaining optical AR coating from the DOF. DOF contractual changes that were ongoing made it difficult to establish a new task with DOF. Computer models were run for coating specifications to be deposited.

Machining of parts for optical and electronic mounting was completed. L/I data was taken on several samples of quantum dot material received from Wright-Patterson AFB. Initial L/I curves indicated poor laser efficiencies, subsequent measurements on different bars showed better characteristics.

Subsequent to this activity the Air Force branch decided to move the laboratory to a new facility. Equipment from the lab was boxed and tables were cleared in preparation for moving. All of the remaining lab equipment was moved into the hanger lab including the Argon-ion laser, the Ti-sapphire laser, spectrometers and the alpha measurement setup. Organization of the new lab was started but was slowed due to changing space requirements within the Air Force branch.

III. CONCLUSION

Alpha measurements made prior to this task suggest that low temperature operation of diode lasers may decrease the alpha parameter leading to improved laser performance. Due to laboratory reorganization and consolidation, technical activity on this task was curtailed, and lowered alpha parameters could not be verified. Continued work in this area is appropriate, and may lead to higher power, higher brightness diode lasers.

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